Why Hydrogen?

Dr. David L. Block

Director Emeritus

Florida Solar Energy Center

(A Research Institute of University of Central Florida)

Challenge

Research and Development to obtain fuel to replace fossil-based fuels

Hydrogen – the perfect fuel

- Abundant, renewable, indigenous, freely available
- All energy needs – combustion to electricity generation
- Least polluting emissions

Fuel for space travel

Fuel for Earth Travel

AUTOnomy *by General Motors*

Fuel to Generate Electricity

Oil Issues

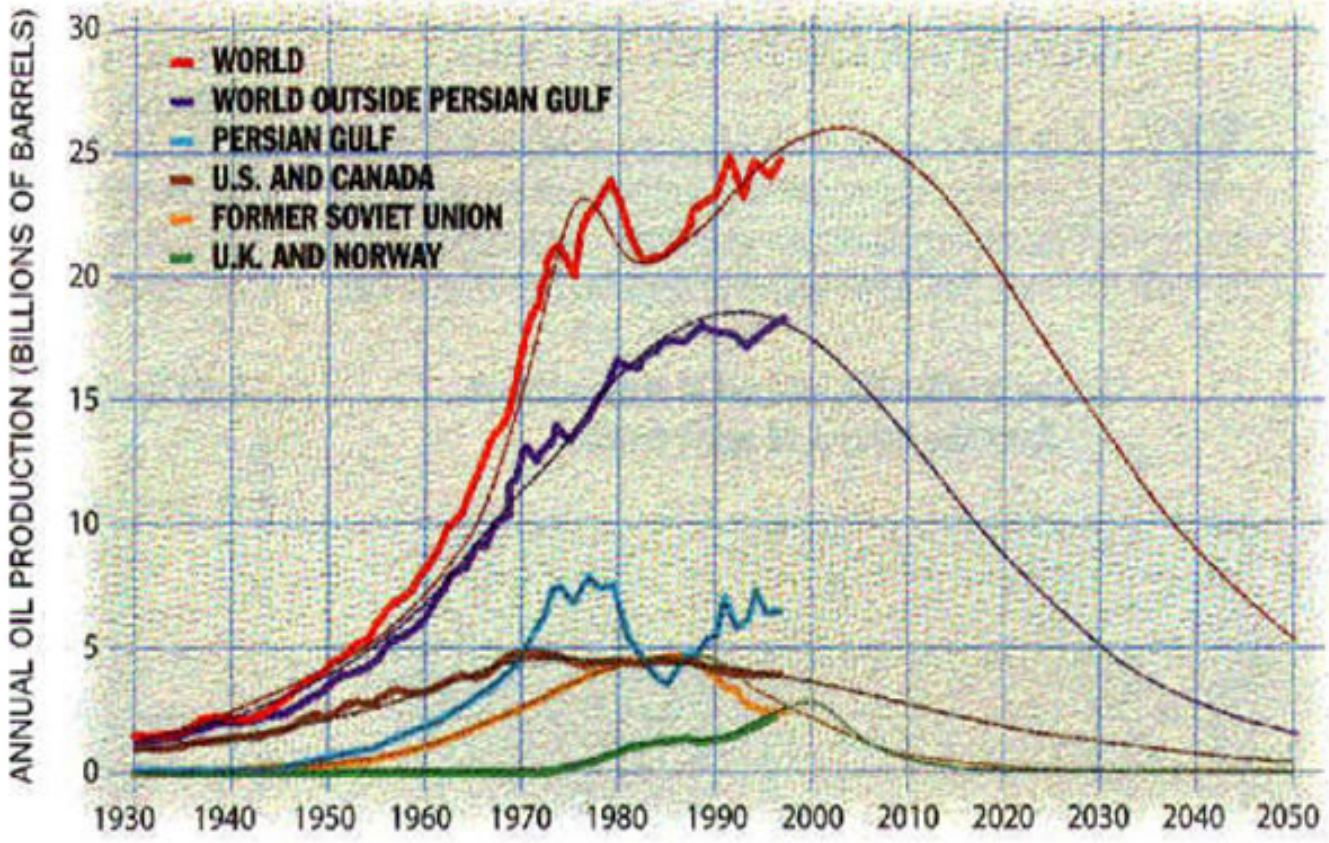
1970's

2000

Oil Issues

- U. S. Imports
- Middle East Supply
- World Oil Production Peak
- Security

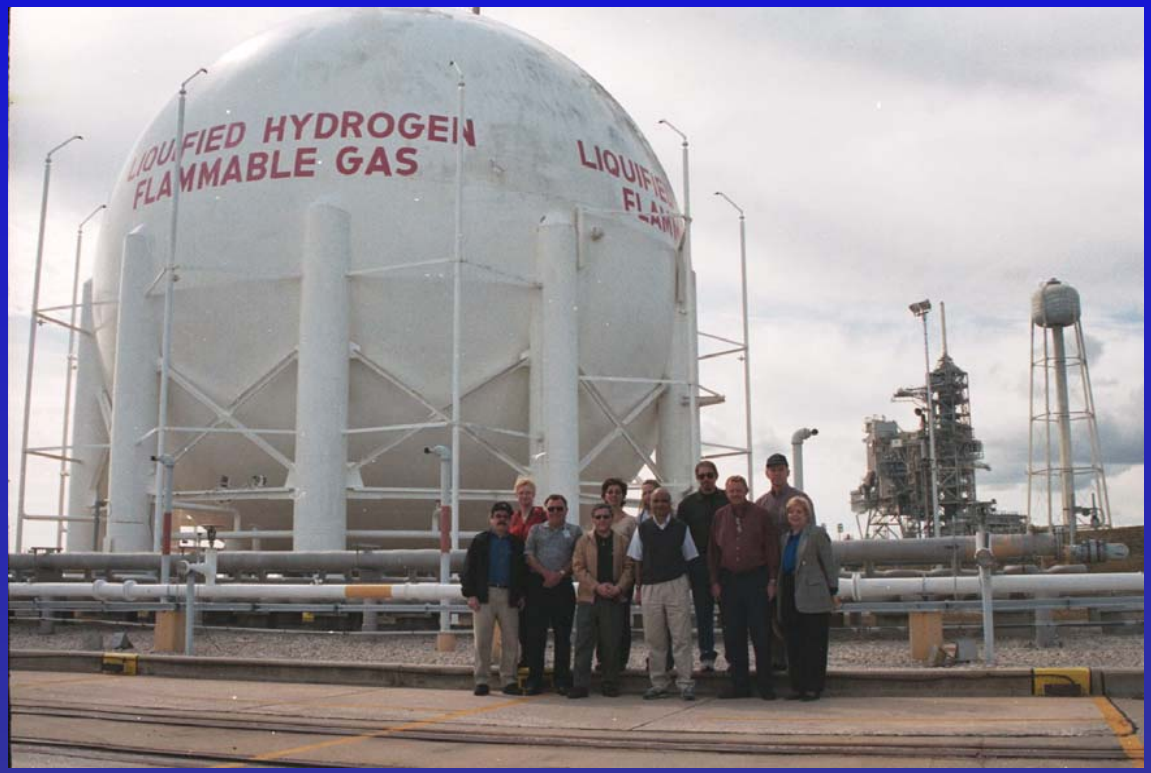
The End of Cheap Oil



Source: Campbell, Colin J. and Jean H. Laherrere, "The End of Cheap Oil." *Scientific American*, March 1998.

Our Conclusion

Hydrogen research and development is vitally important to the nation's and to the world's future.



U.S. DOE Hydrogen Funding

- FY 2001 - $72.6 million
- FY 2002 - $74.0 million
- FY 2003 - $97.4 million

36% Increase

President's Proposal

- FreedomFUEL $1.2 Billion
- FreedomCAR $0.5 Billion

Hydrogen Technology Development Pathway

Production
toughest *problem*
Storage
almost as *difficult*
Utilization
more easily *solved*
Transition
can start *today*

B1-09F

Hydrogen Production Feedstock

- Fossil fuels
- Water
- Biomass

Hydrogen Costs - $/MBtu

Steam reformation of natural gas = 3 x (natural gas cost)

Electrolysis using electricity at $.05/Kwh = $28/MBtu

Hydrogen and Carbon

- Natural gas – limited supplies
- Coal – FutureGen
- Sequestering – critical issue

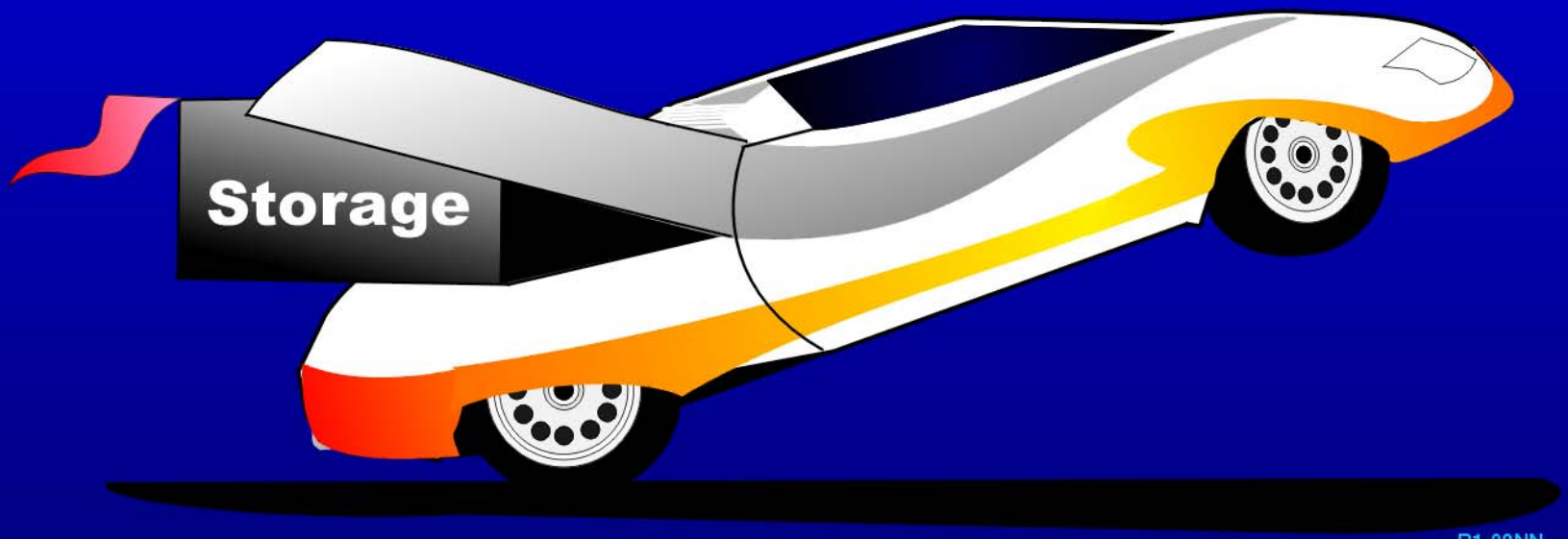
Renewable Based Process

- PV electrolysis
- Photoelectrochemical
- Photobiological
- Thermochemical (high temperature from solar)

Hydrogen Production Process Goals

- Must be driven by renewable energy and use renewable feedstock
- Must become cost-competitive in meeting niche market needs
- Must be capable of scale-up for large markets

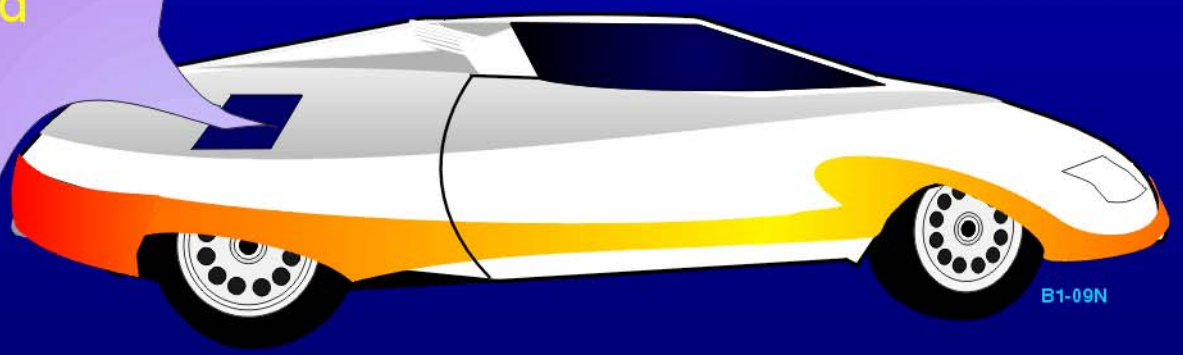
Storage is a Function of Utilization



B1-09NN

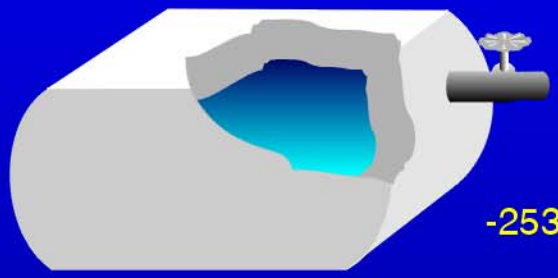
Storage

- No single storage technology satisfies all vehicles.
- Volume, weight and safety are major factors.
- First applications will use an existing liquid fuel and on board reforming.

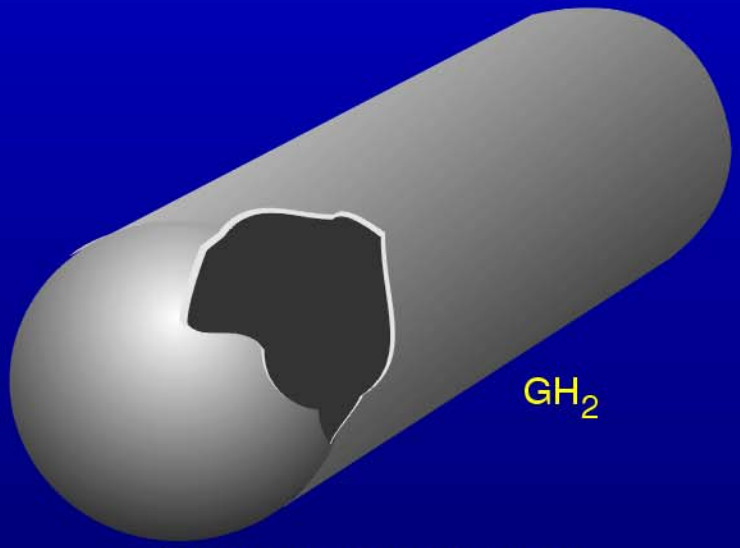


Hydrogen Storage

State of the Art

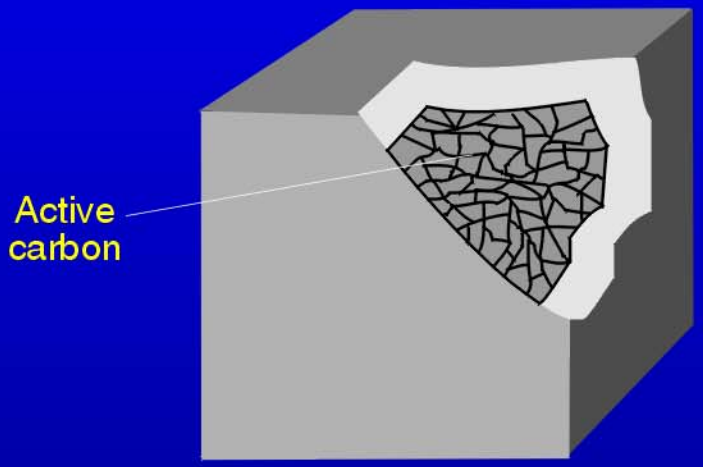


Liquid storage

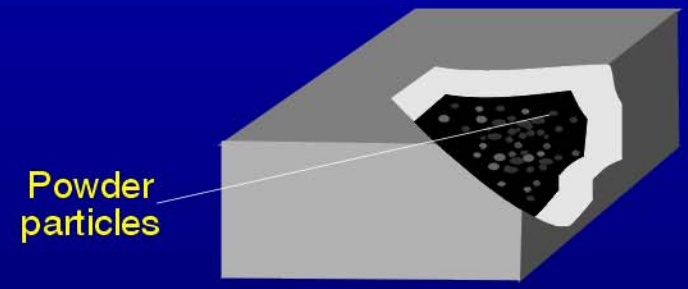


Gas pressure storage

New concepts



Absorber storage



Metal hydride storage

B1-09L

DOE Storage Goals

- 6% by weight
- Cost - $5/Kwh

Fuel Storage Numbers

(for 2000 lb vehicle, 250 mile range, 40 mpg)

Fuel Type	Weight (lbs)	Volume (ft^3)
Gasoline	**50**	**1**
Liquid H_2 – ICE	**90**	**6**
– FC	**40**	**3**
Compressed H_2 – ICE	**1500**	**27**
– FC	**700**	**12**
Lead acid battery	**4700**	**31**
Advanced battery	**650**	**10**

Utilization

Dr. Bain's Hydrogen Car--Refueling

Costs

Internal Combustion Engine	$50/Kw
Fuel Cell	$5,000/Kw

DOE Fuel Cell Goals

- **Efficiency**
  - **Direct 60%**
  - **Reformer 75%**
- **Cost**
  - **$45/Kw by 2010**
  - **$30/Kw by 2015**

Ballard Power Systems

- Reduce or eliminate platinum catalysts

Ballard Fuel Cell

Ownership

- **Daimler Chrysler** **24%**
- **Ford** **20%**
- **Public** **56%**

Elements of Success

- ✓ **Technologies**
  - Solve storage problem
  - Fuel cell vs. ICE
  - Feedstock


Why Florida?
Florida must be a key player in this new industry.

Florida's Strengths

- KSC – World's leading expertise
- KSC – Natural test-bed
- FSEC – Strong technical research staff and resources
- NASA – $8.125 million R&D
- Partnerships – Six Florida Universities and NASA

Florida's Opportunities

- Attract and develop new companies in this infant industry
- Build new industry
- Create new jobs

Why the Florida Solar Energy Center?

FSEC Hydrogen Research

- Since 1983, 31 contracts totaling $10.2 million
- Current NASA hydrogen program funded at $8.125 million
- FSEC has 10 hydrogen-related patents.

NASA/Florida Universities Hydrogen Program

Grant Task	Universities
Densified Propellant Technology	**FSEC, FSU**
Safety & Monitoring Systems	**FSEC, FSU, UCF, UF, USF, UWF**
H_2 Storage for Spaceport & Vehicle Applications	**FSEC,UCF, UF**
Local H_2 Production, Transport & Recovery	**FIU, FSEC, UCF, UF, USF**
New Propellants & Cryofuels	**FSU, UF**
In-space Cryogenic Fluid Management Technology	**UF, USF**
Education & Outreach	**FSEC, UF**

"Dream" Numbers

- Oil produced in U.S. $ 90 billion
- Imported oil $110 billion

Hydrogen fuel potential =

$200 billion/year

"Dream . . ."

- Automobiles produced in U.S. = 17 million/year
- New car sales = $375 billion/year
- Cost of internal combustion engines = $ 25 billion/year

Fuel cell potential=

$50 billion/year

Conclusion

No technology holds greater promise for the future than the technology that can replace the need for fossil fuels –

HYDROGEN.